

circumstance that in the case of the coke-gas fire no heat flashes up the chimney, but is utilised entirely for raising the coke in front of the grate to the condition most favourable to radiation into the room.

I hold that it is almost barbarous to use raw coal for any purpose, and that the time will come when all our fuel will be separated into its two constituents before reaching our factories or our domestic hearths. Such a measure would not only furnish us with the complete solution of the smoke question, but would be of great value also as a money saving. In conclusion I may observe that I have taken up this question without the idea of profit, and shall be happy to furnish builders and others desirous to introduce the grate here described with the necessary indications to insure success. C. WILLIAM SIEMENS

THE RUSSIAN IMPERIAL YACHT, "LIVADIA"

IN NATURE, vol. xxii. p. 270, we gave an account of this remarkable ship, and stated that we should report the results of her trials to our readers. We there said "it cannot be doubted that her speed will surpass 14 knots," and we pretty plainly intimated that it would, in our judgment, fall substantially short of 17 knots; in point of fact it has fallen between these limits, and nearer the higher than the lower, the average mean speed at the measured distance being 15'864 knots. The details of the several runs, which have not previously been published in London, we believe, are as follows:—

No. of Run.	Indicated H.P.	Speed in Knots.
1	12,267	15'69
2	11,704	15'53
3	12,387	15'83
4	12,437	15'65
5	12,857	15'92
6	12,472	15'65
Average		15'725

The trials of the *Livadia* were greatly hurried, the vessel going down the river on a Wednesday, making a preliminary run under steam on the following day, Thursday; on Friday she made a run at full speed for six hours, giving an average of 15 knots; and on Saturday she made her measured mile trials. Those who understand the conditions under which these steam trials were made will see at once that it was not possible to obtain the best results with a ship thus put under steam day after day, her boiler tubes getting doubtless more or less foul, and her machinery also falling somewhat out of perfect condition, especially where there were three separate sets of engines to be cared for. The bottom was also foul from having been three months in the wet dock at Fairfield. The effect of haste in making the trials is visible in the variations of horse-power developed upon the runs, there being a difference of more than 1000 h.p. between the power developed, for example, on the second run as compared with that of the fifth. The speeds given above show less discrepancies than the horse-powers, but it can hardly be doubted that the *Livadia* as she is can be driven at over 16 knots under fair conditions, without any alteration whatever. It is, as has been said elsewhere, highly probable that some improvements might be made in the screw propellers, as it is not to be expected that the best conditions were secured at the first attempt. In fact we have evidence that the central

screw was set at a pitch different from that of the side-screws, and runs at a different speed; it now appears likely that the pitch should have been the same in all cases, and when the opportunity offers this change will probably be made, and the speed again taken. Other slight modifications will doubtless also be tried, and those of our own naval architects, who have well considered all the facts, have formed the opinion that if all minor causes of interference with the best performance are removed, a speed approaching 17 knots may be reached in the *Livadia*. It needs no words of ours to convince the scientific world that whether any great increase of speed be obtained with this vessel or not, the Russian Government has rendered a vast service to naval science by demonstrating on a large scale and in a public and unquestionable manner, the fact that a vessel whose breadth is enormous, and whose length is but one and a half times her breadth, may with no very inordinate expenditure of power be made to take a high place among the few fastest ships of the world.

But the interest in the *Livadia*, while it is greatest as regards her high-speed trials, by no means ends there. Her steaming performances with diminished steam power are also very interesting. In considering these the reader should remember that in this case as in all cases of fast ships going with reduced power and at reduced speed, the performances are subject to a double disadvantage: first the weight of the machinery carried is of course in excess of what is needed to produce the reduced power; and secondly, the friction and other losses are likewise in corresponding excess. For example, when the *Livadia* is steaming say at 11 to 12 knots, she is employing less power than any one of her three sets of engines produces; and if she had not to go beyond such a speed she might dispense with the other two sets of engines and boilers, and thus be relieved of nearly 1000 tons of weight, and of two-thirds of the frictional and other losses which she is obliged to undergo when steaming at 11 or 12 knots with all her engines working at a reduced speed. Bearing these facts in mind, we may now state that the reduced steaming of the *Livadia* is reported officially to have given the following results:—

Aggregate Ind. H.P.	Speed.	Wind.	Tide.
2969	11 knots	With	Slightly
4770	13 "	"	"
8940	15 "	Against	Slightly against
10,937	15 $\frac{1}{4}$ "	"	Against

The indicated horse-powers above given were calculated from diagrams, and the speed was taken by log. The results were reported, we know, in perfect good faith, and are a correct indication, in the main, of the relation between power and speed in the *Livadia* with her present screws, &c. They nevertheless appear to us to exhibit on the face of them some slight discrepancy, which is amply accounted for by the fact that the speeds were, as we have said, taken by the log, which does not admit of that minute accuracy which may and ought to characterise measured mile-trial results. The above figures are borne out by the sea-passages of the yacht. She steamed continuously in fair and moderate weather at an average speed of somewhat more than 12 knots with an average expenditure of about 4000 Ind. H.P.

With all the above facts and figures before us we see

clearly how vain have been the prejudices, and how baseless the predictions, which condemned ships of this type as incompatible with even moderately good speeds, and as ridiculous when the attainment of high speed was contemplated. It is with no small feelings of vanity, but with a genuine pride in a great scientific triumph which we ventured to predict beforehand, that we have witnessed the *Livadia*'s success. It is a success which England may well envy, and of which the Russian Government may well be proud. Its bearing upon the future of steam navigation cannot fail to be considerable even in the mercantile marine, while it is quite impossible for the war navies of the world to escape its influence. Our long-standing objections to the *Inflexible* and *Italia* types of ship are well known to our readers, the construction of such ships under the name of first-class ironclads being most trying even to the common sense, and much more to the scientific sense, of the country. With the *Livadia* in existence, and with the facilities which such great breadth as hers offers to the production of armoured ships worthy of the name, the exposure of our first-class ships to the destructive effects both of shells and of torpedoes, will not be endured. We congratulate Admiral Popoff upon the established success of the great idea which he was the first to propound, and as the idea would still have remained a mere idea but for the powerful patronage of the Grand Duke Constantine, we gladly recognise again the scientific acumen and that "courage of his opinions" which distinguish His Imperial Highness. By consenting to the trial of so great a naval experiment in a yacht of his own, the Emperor of Russia has secured a sea-palace of great speed, of unexampled accommodation, and of a freedom from rolling and pitching such as no other ship in the world enjoys.

On the last-named points—those of pitching and rolling—we have to record very remarkable results. We are informed on the best authority that in the gale in the Bay of Biscay, with waves running over twenty feet high, when ordinary vessels were seen rolling and pitching heavily, and even when the gale and the sea were at their highest, the greatest roll to leeward was 5 degrees, and that to windward 4 degrees, while the greatest pitch was 4 degrees and the greatest "scend" 3 degrees. This extreme limitation of motion was most extraordinary, excluding almost all the usual incidents of sea-life. Nothing was secured on board, and nothing fell throughout the storm. There were occasionally heavy blows of the sea under the flat shallow bow, and these caused much vibration at times; but nothing was disturbed, and even the paint is nowhere cracked throughout the wood-built cabins and palaces of the ship.

In the accident which the *Livadia* met with on her voyage from Brest to Ferrol, by striking heavily downwards upon some floating object or objects during a heavy gale in the Bay of Biscay, with a high and confused sea running, the value of water-tight subdivision has been strikingly demonstrated. The injuries done by the blows were extended by the heavy strokes of the sea under the bluff bow, and several of the forward compartments were filled. A scientific friend who inspected the bow after the compartments were pumped out in the harbour of Ferrol, informs us that in two or three places the bulk-head divisions had evidently been badly struck and made

leaky at the bottom, and in one compartment the sea was plainly visible through the broken plating. And yet nothing was known on board of these injuries when at sea beyond the fact (ascertained by "sounding") that a forward compartment of the double bottom had been somehow filled, so effectually was the ship proper preserved from all injury within the double bottom, and so little effect had the filling of the forward spaces upon the trim and behaviour of the ship! The *Livadia* is constructed of steel, and is as lightly built as our own fast steel ships of the latest date; and as a similar accident to the recent one might occur again, as it may to any ship of light draught and great buoyancy, it would no doubt be prudent to add something to the strength of the outer bottom where most exposed to strains and blows; but this is a matter of detail which we leave the naval architect to discuss. The great lesson to be derived from the incident is the immeasurable value of double bottoms and of great compartmental subdivision in sea-going structures. An ordinary large steam yacht not so subdivided might have been lost under like circumstances, and certainly would have been more or less jeopardised and more or less injured internally; in the present case not a particle of injury to the interior of the ship or to her costly fittings was sustained, and hours after the accident, with a very high and confused sea still running, the Lord High Admiral of Russia and his guests dined as safely, as easily, and almost as quietly as if he had been ashore in his summer palace of Orianda.

A MEDICAL CATALOGUE

Index Catalogue of the Library of the Surgeon-General's Office, U.S. Army. Vol. i., A—Berliński. 4to, pp. 888. (Washington : Government Printing Office.)

THE saying of Hippocrates, that art is long and time is short, is so true, not merely of medical art, but of work in general, that most working men find their lives gliding so quickly away that they do not attempt great works, and very probably would not succeed if they did so. But every now and then we come across men whose energy is so marvellous, and whose power of getting through work is so enormous, that we are struck with amazement at it. Such a man is Dr. Billings, to whose extraordinary energy and perseverance we owe the present work. This purports to be only a catalogue of the Library of the Office of the Surgeon-General of the United States Army, and Dr. Billings takes care to call attention to the fact that it is not a complete medical bibliography, and that any one who relies upon it as such will commit a serious error. "It is," he says, "a catalogue of what is to be found in a single collection; a collection so large, and of such a character, that there are few subjects in medicine with regard to which something may not be found in it, but which is by no means complete." It is not, however, a mere catalogue in the ordinary sense of the word, inasmuch as its contents are not confined to the names and titles of books and their authors. It is also a catalogue of subjects, so that any one wishing to read up a particular subject will find under the appropriate heading a list of the chief works bearing upon it. Nor is this all. There are other catalogues in which a similar arrangement has not only been